British Standard

BRITISH STANDARD

BS 3892 :
Part 2 : 1996

Pulverized-fuel ash

Part 2. Specification for pulverized-fuel ash to be used as a Type I addition

ICS 91.100.30

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee B/516, Cement and lime, to Subcommittee B/516/101, Pozzolanas, upon which the following bodies were represented:

British Aggregate Construction Materials Industries
British Cement Association
British Precast Conrete Federation
British Ready Mixed Concrete Association
Cementitious Slag Makers' Association
Department of the Environment (Building Research Establishment)
Electricity Association
Federation of Civil Engineering Contractors
Quality Ash Association

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The following BSI references relate to the work on this standard:
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Contents

Foreword

This Part of BS 3892 has been revised by Subcommittee B/516/101, in order to bring BS 3892 into line with current practice followed in the selection and use of pulverized-fuel ash (pfa) in concrete. Together with BS 3892 : Part 3[1)] it supersedes BS 3892 : Part 2 : 1984, which is withdrawn.

Pulverized-fuel ash is extracted from the flue gases of furnaces fired by pulverized bituminous or other hard coals. It is a fine material, predominantly of spherical glassy particles. By virtue of its particle size and shape it can act as a plasticizer in concrete mixes allowing the water content to be reduced. Though not reacting directly with water, it can react with the calcium hydroxide in solution produced in the hydration of Portland cements to form additional insoluble hydrates and thus impart a certain degree of strength to a concrete.

This Part of BS 3892 specifies one grade of pfa that may have a fineness, expressed as a 45 μm sieve residue of up to 60 % and a loss on ignition of up to 12 % for use in concrete as a Type I addition (nearly inert). The reduction in water requirement and the pozzolanic activity that can be achieved are not normally as great as those obtainable with pfa conforming to Part 1 of BS 3892, which gives the requirements for pfa to be used as a Type II addition (pozzolanic or latent hydraulic) in concrete. The definitions of these Types in clause **3** are taken from DD ENV 206.

This revision introduces the following changes from the 1984 edition:

a) additional information regarding the chloride and calcium oxide contents is now available if requested at the time of ordering;

b) the methods of sampling and testing are now in accordance with BS EN 196;

c) the requirement for magnesium oxide has been removed as research has found no evidence of periclase in pfa from bituminous or other hard coals;

d) additional guidance on use, safety precautions and storage has been added in annex A.

Part 1 of BS 3892 specifies more stringent requirements for a processed pfa for use as a cementitious component, Type II addition, in concrete. It gives requirements for particle density, water requirement, strength factor, initial setting time, soundness, chloride content and calcium oxide content in addition to those given in Part 2. Both fineness, at 12 % sieve residue and loss on ignition, at 7.0 % are more closely controlled.

BS EN 450 specifies an unprocessed fly ash for use as a Type II addition in concrete conforming to DD ENV 206. The fineness has a maximum limit value of 45 % sieve residue and the loss on ignition a maximum limit value of 7 % with 9 % allowed on a national basis.

Part 3 of BS 3892 specifies pfa for use with Portland cement in grouts.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

[1)] In preparation.

Specification

1 Scope

This Part of BS 3892 specifies requirements for the chemical and physical properties, composition, production, sampling, testing and marking of pulverized-fuel ash (pfa) suitable for use as a Type I addition in concrete.

The requirements in this Part are given as absolute upper or lower limit values.

This Part of BS 3892 does not give the requirements for pfa to be used as a cementitious component in concrete.

2 References

2.1 Normative references

This Part of BS 3892 incorporates, by reference, provisions from specific editions of other publications. These normative references are cited at the appropriate points in the text and the publications are listed on the inside back cover. Subsequent amendments to, or revisions of, any of these publications apply to this Part of BS 3892 only when incorporated in it by updating or revision.

2.2 Informative references

This Part of BS 3892 refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions

For the purposes of this Part of BS 3892, the definitions given in BS 6100 : Section 6.1 : 1984 apply together with the following.

3.1 Type I addition

Finely divided inorganic nearly inert material that may be added to concrete in order to improve certain properties or to achieve special properties.

3.2 Type II addition

Finely divided inorganic pozzolanic or latent hydraulic material that may be added to concrete in order to improve certain properties or to achieve special properties.

3.3 spot sample

Sample taken at the same time and from one and the same place relating to the intended tests. It can be obtained by combining one or more immediately consecutive increments.

3.4 hard coal

Coal blend giving a gross calorific value of not less than 24 MJ/kg on a dry ash-free basis when tested in accordance with BS 1016 : Part 105 : 1992.

3.5 conditioned pfa

Pulverized-fuel ash that has been treated with a quantity of water.

4 Composition and production

Pulverized-fuel ash conforming to this standard is a fine powder of mainly spherical glass particles which shall consist essentially of reactive silicon dioxide (SiO_2) and aluminium oxide (Al_2O_3), the remainder being iron (III) oxide (Fe_2O_3) and other oxides.

Pulverized-fuel ash shall be obtained by electrostatic or mechanical precipitation of the dust-like particles found in flue gases of power station furnaces fired with pulverized bituminous or other hard coals. Ash from other coals or obtained by other means is not covered by this standard.

5 Moisture content

The moisture content of the pfa shall not be more than 0.5 % when determined in accordance with the method described in annex C of BS 3892 : Part 1 : 1993. For conditioned pfa, the moisture content shall not be more than the value declared by the producer.

6 Fineness

The fineness of the pfa, expressed as the proportion by mass retained on a 45 μm test sieve conforming to BS 410, shall not exceed 60 % when determined in accordance with the method described in annex D of BS 3892 : Part 1 : 1993.

7 Chemical composition

7.1 General

The chemical composition shall be expressed as proportions by mass of dry pfa prepared as described in annex C of BS 3892 : Part 1 : 1993.

7.2 Sulfuric anhydride

The content of sulfuric anhydride (SO_3), shall not be more than 2.5 % (m/m) when determined in accordance with clause **8** of BS EN 196-2 : 1995.

7.3 Loss on ignition

The loss on ignition shall not exceed 12.0 % (m/m) when determined in accordance with clause **7** of BS EN 196-2 : 1995, but using an ignition time of 1 h.

8 Marking

Pulverized-fuel ash shall be marked on the bag or the delivery note and on any certificate with the following particulars:

a) the name, trademark or other means of identification of the producer;

b) the source of the material;

c) the name of the material, i.e. pulverized-fuel ash;

d) the number and date of this British Standard, i.e. BS 3892 : Part 2 : 1996[2)].

9 Information to be provided

If a test certificate is requested, it shall include results of the following tests on samples of the pfa relating to the material delivered:

a) moisture content;

b) fineness (45 μm sieve residue);

c) sulfuric anhydride content;

d) loss on ignition.

If requested at the time of ordering, the certificate shall also include (for samples dried as required by **7.1**):

e) chloride ion content (% *m/m*), determined in accordance with clause **4** of BS EN 196-21 : 1992;

f) calcium oxide content (% *m/m*), determined in accordance with clause **13** of BS EN 196-2 : 1995;

g) acid soluble alkali content (% *m/m*), determined in accordance with **7.5.2** of BS EN 196-21 : 1992 or by an X-ray fluorescence technique calibrated against the method described in **NA.5.2** of BS EN 196-21 : 1992, and/or the water soluble alkali content.

10 Sampling and testing for acceptance inspection at delivery

10.1 When required by the purchaser for assessing conformity at delivery, a spot sample of the pfa shall be taken in accordance with **3.6** and **6.2** or **6.4** of BS EN 196-7 : 1992 either before, or at the time of delivery. A laboratory sample shall be prepared and packed in accordance with clauses **8** and **9** of BS EN 196-7 : 1992. A sampling report shall be completed at the time of sampling and shall be attached to the laboratory sample in accordance with clause **10** of BS EN 196-7 : 1992.

10.2 When the pfa is tested for chemical composition (see clause **7**), the sample shall be prepared by the method described in clause **6** of BS EN 196-2 : 1995 except that it is not required to pass a magnet over the pfa to remove metallic iron.

[2)] Marking BS 3892 : Part 2 : 1996 on or in relation to a product represents a producer's declaration of conformity, i.e. a claim by or on behalf of the producer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with the third party certification of conformity, which may also be desirable.

Annex

Annex A (informative)
Product guidance

A.1 Safety warning

Dry pfa in normal use has no harmful effect on dry skin. Precautions should however be taken to avoid such material entering the eyes, mouth and nose and to prevent skin contact with wet pfa.

When working in places where dry pfa becomes airborne, protection for the eyes, mouth and nose should be worn. If pfa enters the eye it should immediately be washed out thoroughly with clean water and medical treatment should be sought without delay.

This part of this standard applies to pfa to be used in conjunction with Portland cement and other materials in concrete. When working with wet concrete, waterproof or other suitable protective clothing should be worn such as sleeved shirts, full length trousers, waterproof gloves and wellington boots. Clothing contaminated with wet pfa, cement or concrete should be removed as soon as possible and washed before further use. Wet concrete on the skin should be washed off immediately.

Repeated skin contact with wet cement over a period may cause irritant contact dermatitis. Although no connection has been established between pfa and dermatitis, this possibility cannot be ruled out. The abrasiveness of the particles of cement and pfa in concrete can contribute to this effect. Continued contact during a working day can lead to alkali burns with ulceration, but this is not common.

A.2 Storage[3)]

Separate storage should be provided for different types of pfa which should be clearly identified.

To protect the pfa after delivery, bulk silos should be waterproof and internal condensation minimized.

Pulverized-fuel ash supplied in paper bags should be stored clear of the ground and interlocked for stability, not more than eight high and protected by a waterproof structure.

Conditioned ash may be stored in stockpiles. Dust emission can be avoided either by covering the pile or spraying the surface with water.

A.3 Use with admixtures

Where admixtures are to be used, their suitability for use with pfa and cement combinations should be evaluated.

A.4 Alkali-silica reactivity

Where there are circumstances in which the alkali-silica reactivity needs to be considered, users should obtain specialist advice.

A.5 Colour

Pulverized-fuel ash may vary in colour from light to dark grey with shades of brown occurring as well. An indication of consistency of colour may be given by the use of any test mutually agreed between producer and purchaser. A colour comparator is suitable for this purpose. When using exposed concrete it should be borne in mind that the colour of the pfa received may become significantly darker on mixing because the carbon particles will become ground and behave as a pigment. The colour of the ash with a high loss-on-ignition will generally be darker than that with a low value due to a higher carbon content. Colour consistency of any concrete is difficult to achieve owing to the effects of aggregate type and grading, cement colour, curing of the concrete and moisture content.

[3)] See also the Environmental Protection Act 1990 Part 1 and the Secretary of State's Guidance note PG3/1.

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List of references (see clause 2)

Normative references

BSI standards publications

BRITISH STANDARDS INSTITUTION, London

BS 410 : 1986	*Specification for test sieves*
BS 1016 :	*Methods for analysis and testing of coal and coke*
BS 1016 : Part 105 : 1992	*Determination of gross calorific value*
BS 3892 :	*Pulverized-fuel ash*
BS 3892 : Part 1 : 1993	*Specification for pulverized-fuel ash for use with Portland cement*
BS 6100 :	*Glossary of building and civil engineering terms*
BS 6100 : Part 6 :	*Concrete and plaster*
BS 6100 : Section 6.1 : 1984	*Binders*
BS EN 196 :	*Methods of testing cement*
BS EN 196-2 : 1995	*Chemical analysis of cement*
BS EN 196-7 : 1992	*Methods of taking and preparing samples of cement*
BS EN 196-21 : 1992	*Determination of the chloride, carbon dioxide and alkali content of cement*

Informative references

BSI standards publications

BRITISH STANDARDS INSTITUTION, London

BS 3892 :	*Pulverized-fuel ash*
BS 3892 : Part 3 : 1996[4)]	*Specification for pfa for use in cementitious grouts*
BS EN 450 : 1995	*Fly ash for concrete. Definitions, requirements and quality control*
DD ENV 206 : 1992	*Concrete. Performance, production, placing and compliance criteria*

[4)] In preparation.

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